PEDESTRIAN FRIENDLY GRADE SEPARATED PEDESTRIAN CROSSING

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By

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FINAL YEAR PROJECT REPORT

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CERTIFICATION OF APPROVAL

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Civil Engineering Programme
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Approved:

(Assoc. Prof. Dr. Madzlan Napiah)
Project Supervisor

UNIVERSITI TEKNOLOGI PETRONAS
TRONOH, PERAK

January 2009

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

(Mohamad Azril Bin Mohamad Anuar)

ABSTRACT

The current design of the overpass is not user friendly especially for children, elderly and disable peoples. It leads the pedestrian to take shortcut by crossing at road level and risking their safety. Some surveys have been done show that 88% of pedestrian refuse to use the overpass. Using the overpass take more time and distance. It's also need to use stair to reach certain level before crossing the road. With this difficulties and problems the ideas of Pedestrian Friendly Grade Separated Pedestrian Crossing have come out. The idea is instead the pedestrian going above the vehicle, why doesn't vehicle go up above the pedestrian. This new crossing design is to eliminate pedestrian vertical movement, give short crossing distance and give less crossing time for the pedestrian, motorcyclist and bicyclist. This will guide the pedestrian to use the proper crossing facilities to crossing the road. Hence, it will reduce the number of the people crossing without using the proper crossing facilities. The crossing can be design for vehicle below 2.5m to access the school from both directions. The cost to construct this new crossing is not so expensive compare to the current overpass structure make this new design possible to be construct in the future.

ACKNOWLEDGEMENTS

The author wishes to take the opportunity to express his utmost gratitude to the individual that have taken the time and effort to assist the author in completing the project. Without the cooperation of these individuals, no doubt the author would have faced some minor complications throughout the course.

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The author also would like to extend her appreciation to all her colleagues for their fully supports and collaboration. Last but not the least, the author wishes to express his heartfelt appreciation to her parents and family members for their moral support.

Hopefully, this work can be used and appreciated for those who are interested to make further studies or studies related to this field. The author felt very grateful to give contribution for the future development.

TABLE OF CONTENTS

LIST OF TABLES

CHAPTER 1
INTRODUCTION

1.1 Project Background

A pedestrian crossing or crosswalk is a designated point on a road at which some means are employed to assist pedestrians wishing to cross. The common type of pedestrian crossing it is zebra crossing. Zebra crossing comes with black and white stripes across the road and orange beacons on each side. Drivers must give way to pedestrians, who should check that all traffic has stopped before crossing. This type of crossing is applicable with moderate volume of traffic. High volume of traffic normally uses the separated pedestrian crossing.

The separation pedestrian crossing is the structure that removes the conflicts between the pedestrians and vehicles at the roadway. This will remove the conflict between the pedestrians and vehicles without delay the vehicle time. It's mean that, the separated pedestrian crossing will not slow down the traffic flow when the pedestrians cross the road. This can be considered a type of grade separation structure on the road. These structures can be located either above or below the roadway. The structure located below the road we called it underpass (most often these would be culverts).

In the United State of America there are tunnels under major roadways provided in wilderness areas to let the animal cross roadways without having conflicts with the vehicles. Even though it built for animal crossing but it also had been used by people at those areas.

Many type of grade separated crossing let pedestrian to go above the road or below the road. This project will design a pedestrian friendly separated pedestrian crossing without the pedestrian change elevation when crossing.

1.2 Problem Statement

The overpass is one of the most popular grade separated pedestrian crossing using in Malaysia. Most of the overpass in Malaysia has been build near school that located beside the high volume traffic road or more than 4-lane roadways. It also builds for the pedestrian to cross a highway. In the city the overpass is design for pedestrian to cross the busy road. The overpass is providing whether with staircase, ramp or both. The ramp normally is provided for disabilities people, motorcycle and bicycle to use the walk bridge to cross the road.

The government has spent a lot of funds in construct the overpass but the use of the overpass is not being optimized by the pedestrian. Furthermore, the design of the overpass is not user friendly especially for children, elderly and disability peoples. Only certain area in the big city like Kuala Lumpur been provided with escalator. The inconvenient design of the walk bridge will lead the pedestrian to take the shortcut by crossing at road level. The pedestrian would not use the overpass, because using overpass will increase the walking distance compare to crossing on road level. When the pedestrian crossing without using the overpass, they are risking their safety. The pedestrian will interrupt the traffic flow. This problem also will slow down the flow of vehicle at the road.

It is important to outcome with a new grade separated pedestrian crossing to overcome these problems. The new separated pedestrian will be user friendly and can be use by the children, elderly and disable people. With this type of crossing will lead more pedestrian to use it and will decrease the accident of the pedestrian been hit by vehicle. The most important is to create safe crossing for the pedestrian.

1.3 Objectives

The objectives of is these projects are:

- To assess the utilization of pedestrian on overpass.
- To design a safe and friendly grade separated pedestrian crossing.

1.4 Scope Of Study

The scopes of study in this project include the study of the pedestrian crossing system especially on grade separated crossing. Gain information and studied about the selected overpass structure that will replace with a new design of crossing that will be more user friendly. The research and studied of design standard need to done to fulfill the design requirement according to the standard. The study cover to estimate the cost of the new proposed concept of pedestrian crossing.

CHAPTER 2
LITERATURE REVIEW

2.1 Pedestrian Crossing Type

In Malaysia, the current facilities provided to assist pedestrian to cross busy road include:

- Pedestrian Overpass and Subways,
- Signalized Pedestrian Crossings,
- Pedestrian (`Zebra') Crossings,
- School Children's Crossings,
- Combined `Zebra' and Signalized Pedestrian Crossings.

In respect to pedestrian overpass and underpass, there is strong evidence that the majority of those which have been built across non-expressway routes have poor utilization. For Zebra type pedestrian crossings, some confusion about the obligations between vehicle drivers and pedestrians at this crossing. The give-way obligation by vehicle drivers when pedestrian enter the crossing is not been practice and no enforcement of this obligation by police.

From the current facilities provided to pedestrian to cross street we can conclude it into three type pedestrian crossing facilities:

- Uncontrolled Crossings
- Controlled Crossings
- Grade Separated Crossings

Uncontrolled crossing can be happen at any location where pedestrians find it safe and suitable to cross a road. The crossing becomes more known where pedestrian movements are intense such as at intersections, near bus stops etc. In general these uncontrolled crossings are simply provided with nothing more than ramps at kerblines to bring the footpath down to explicit warrants are not necessary.

At some area with high traffic flow rates, the above `un-controlled crossing' treatments may not provide adequate safety, or capacity (for heavy pedestrian demands), and some form of "Special (Grade) Separation" or some form of "Time Separation" of the pedestrian – vehicle conflict is necessary. This includes:

- The zebra crossing which the vehicle driver must give-way to the pedestrian,
- School student crossing either with or without traffic controller,
- Signalized crossing where the pedestrian and vehicle alternate in the 'right of way' according to pre-set cyclic phasing or there is button for pedestrian to push when needed.
- Manual traffic controlled by the policeman or other authorities like school children crossing supervisor.

For the grade separated crossing, based on the U.S. Department of Transportation, Signalized Intersections: Informational Guide (2004) mention that separating pedestrian movements from an intersection may be feasible in some situations. Pedestrian overpass and underpass create an uninterrupted flow of pedestrian movement separate from the road traffic. Feng S. et al., (2007) found that setting signalized or unsignalized crosswalk can considerable decrease the vehicle delay when the vehicle and pedestrian traffic number large. However this method will increase the travel distance of the pedestrian for both horizontal and vertical distance. Grade separated pedestrian crossing may be possible in situations where:

- The crossing area have high conflict between the pedestrian and vehicle
- There is a high number of children crossing who regularly cross. Mostly at location near school
- The high-risk and extreme crossing for pedestrian.

- High pedestrian volumes at the location and a high demand to cross.
- High volumes of motor vehicles traveling at high speeds along the roadway.
- No suitable option crossing places nearby.
- Financial support and a specific need for the overpass/underpass.
-

2.2 Issue on Pedestrian Grade Separated Crossing

Pedestrian grade separations preferably should entirely remove any conflicts between pedestrian and vehicle at the intersection. However, studies have shown that many pedestrians will not use overpasses or underpasses if they can cross at road level in about the same amount of time, or if the crossing takes them out from their destination or way. Figure 2.1 show the Pedestrian Grade Separated Pedestrian Crossing.

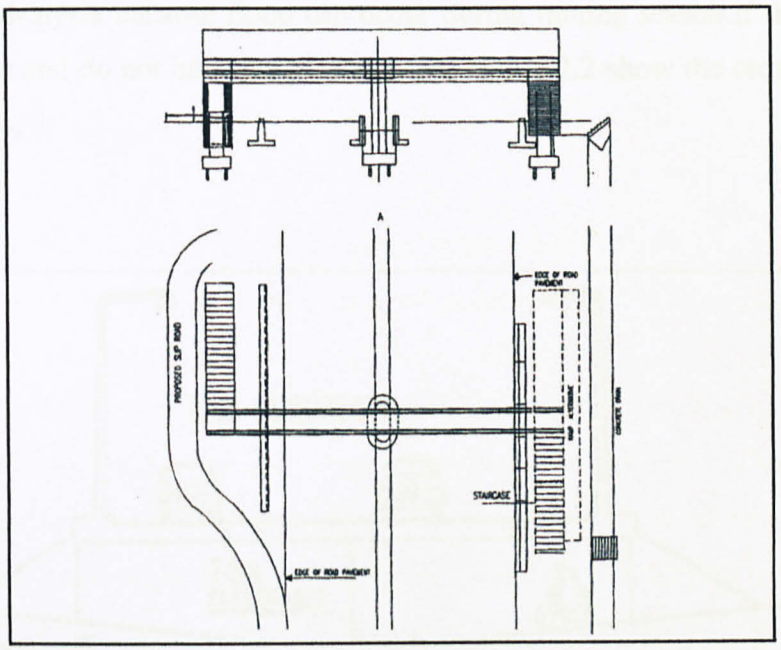

Figure 2.1: Grade Separated Pedestrian Crossing (overpass)

The Pedestrian grade separation will limit the pedestrian access and make the pedestrian less convenience. Pedestrians with disabilities or low stamina especially children and elderly may have difficulty to use with the out-of-direction travel and elevation changes make by the grade separation.

Mikko R. et al.,(2007) found that the pedestrian will use the walk bridge when there are frequently use and seeing bridges use as time saving and safety awareness. The study suggests that bridge use or non-use is a habit and not coincidental behavior. For increasing the pedestrians' bridge use, escalators seem to be a good solution, but traffic signals under a bridge may decline the use rate. In the design perspective improving accessibility by increasing the number of the stairways leading to the bridge does not seem to influence use rate of bridge. The study shows that the important factors to increase the rate of bridge use were safety benefits and convenience of using the bridge without considerable time loss.

The underpass may bring insecure feeling for the pedestrian than overpass The overpass can be safer because they are more open. To design the underpass should allow people from outside see the activity inside the underpass and people can see through the underpass. Lighting of the underpass is very important. If the underpass design for pedestrian and bicycle, it's should be separated. The underpass is not familiar in Malaysia because flood can occur during raining season if there poor of maintenances and do not have proper drainage. Figure 2.2 show the cross section of the underpass.

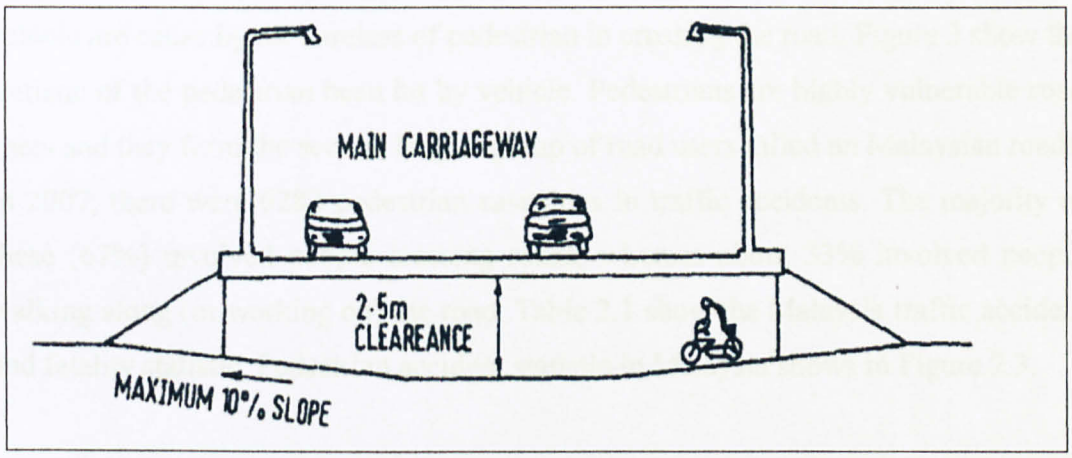

Figure 2.2: Underpass for motorcyclist and pedestrian.

2.3 Pedestrian Crossing Accident

The pedestrian safety is not the new issue in Malaysia. Almost everyday we can see the in the news reported about the accident among the pedestrian.

The Star Newspaper reported "Pedestrian killed while crossing expressway". A pedestrian was knocked down and killed when he was crossing the 9th kilometer stretch of the Damansara-Puchong Expressway on 21st March 2008. The pedestrian was died on the spot. The driver who hit pedestrian is injured. Based on the newspaper

Malay Mail Newspaper have report in headline title "Accident live impact of student" about accident involving a form one student that give impact to his schoolmate (Badrul Hisham, (1999)) .The observation made by the school show that the student turned back than rather cross the Punchong – Damansara Highway. The accident was happen on February 23 1999. Muhd Hasvir Hasni was knocked down by car while crossing the highway.

2.4 Accident Statistic

According Royal Police Malaysia (PDRM), most accident between pedestrian and vehicle are cause by the careless of pedestrian in crossing the road. Figure 3 show the statistic of the pedestrian been hit by vehicle. Pedestrians are highly vulnerable road users and they form the second largest group of road users killed on Malaysian roads. In 2007, there were 6282 pedestrian casualties in traffic accidents. The majority of these (67%) involved people crossing roads, whereas about 33% involved people walking along (or working on) the road. Table 2.1 show the Malaysia traffic accident and fatality statistic. Pedestrian accident statistic in Malaysia shows in Figure 2.3.

Table 2.1: Malaysia traffic accident and fatality statistic

Accident	2002	2003	2004	2005	2006	2007	2008 Jan-Jun
Fatalities	5,378	5,634	5,678	5,623	5719	5672	3,018
Severe	6,696	7,163	7,444	7,600	7373	7384	3,632
Minor	30,259	31,357	33,147	25,905	15596	13979	6,690
Damaged	237,378	254,499	280,546	289,136	312564	336284	170,357
Total	**279,711**	**298,653**	**326,815**	**328,264**	**341252**	**363319**	**183,357**

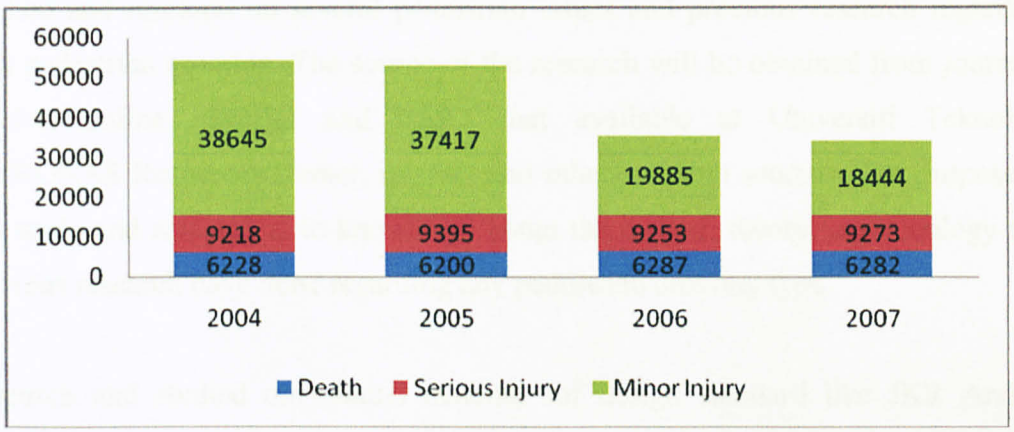

Figure 2.3: Pedestrian accident statistic in Malaysia

CHAPTER 3
METHODOLOGY

3.1 Literature Review Research

Studied and research on several pedestrian issues and previous research regarding with pedestrian crossing. The source of the research will be obtained from journals, articles, online material and books that available at Universiti Teknologi PETRONAS Resources Center, internet and others reliable sources. The purpose of this study and research is to knowledge about the project, theory, methodology and previous research have done regarding any pedestrian crossing type.

Research and studied on manual material for design standard like JKR Arahan Teknik Jalan. This is to know the specification that required to design pedestrian and cyclist facilities. This all for the new design of crossing where required elevation of the highway.

3.2 Studied on Overpass Structure

Before start to design the new pedestrian crossing, some studied about the current overpass structure need to be done. This is including determining the specification of the overpass. Specification of the overpass height that pedestrian need to reach to cross the road, the length of the overpass and the path that pedestrian have to take when their using the overpass. The cost of construct of each of the walk bridge needs

to be concern. The data can be obtained from Jabatan Kerja Raya (JKR), contractors or consultants that involve in construct the overpass.

3.3 Survey of Pedestrian Utilization on Overpass

To assess the utilization of pedestrian on overpass some surveys have been done. The survey was conduct on two selected existing overpass, which are the overpass at Jalan Panglima Bukit Gantang Wahab (in front Bank Islam), Ipoh and Ipoh-Lumut Highway, Titi Gantung (in front Sekolah Kebangsaan Titi Gantung).

In the survey, the numbers of pedestrians use or not use the overpass have been determined. The time taken, distance and other related parameters that pedestrian take when using the overpass will be also determined. This is to compare with parameters with the new design grade separated crossing later. Figure 3.1 show some of the pedestrian do not use the overpass.

Figure 3.1: Pedestrian Utilization of overpass observation at Jalan Bukit Gantang Ipoh

3.4 Conceptual Design

The first design step is the conceptual design. This is where we get the first idea to get the concept of this crossing. In this design stage, the design of the pedestrian crossing will determined how the crossing works. The movement of pedestrian in crossing and traffic flow of vehicles need to be setup. The design will be follow JKR standard (Arahan Teknik (Jalan) 10/86 : A Guide on Design of Cycle Track, Nota Teknik (Jalan) 18/97: Basic Guideline on Pedestrian Facilities and Arahan Teknik (Jalan) 8/86: A Guide on Geometric Design of Roads).

3.5. Structural Design

After the conceptual design it comes to structural design. In this structural design, the type of structures that will be use in this crossing will be determined. The material can be determined by consult with the contractors and suppliers in market or by the internet. From the design, the cost of the grade separated crossing can be obtained. It is important to determine the cost of this new grade separated crossing project to show the feasibility of this project.

The geometry design also designs in this stage. The geometry design is including the design of pedestrian and road lane width, gradient of the road that climb the embankment, bus laybyes design and others road facilities.

3.6 Estimation of Cost

The cost it is important to see the feasibility of the project. This is including the material cost and construction cost. The cost can be determined by consult with supplier of materials and contractor which have experience construction in this field. The cost is including the material cost and installation cost. After obtain the cost then it will be compare with the overpass cost.

3.7 Drawing and Documentation

The final outcome of this project we will come out with the documentation and drawing of the new design. The documentation will have all the detailed about the new design including the drawing. AutoCAD 2007 is use to draw the 2D and 3D drawing of this project. The interface of AutoCAD 2007 shows in figure 3.2.

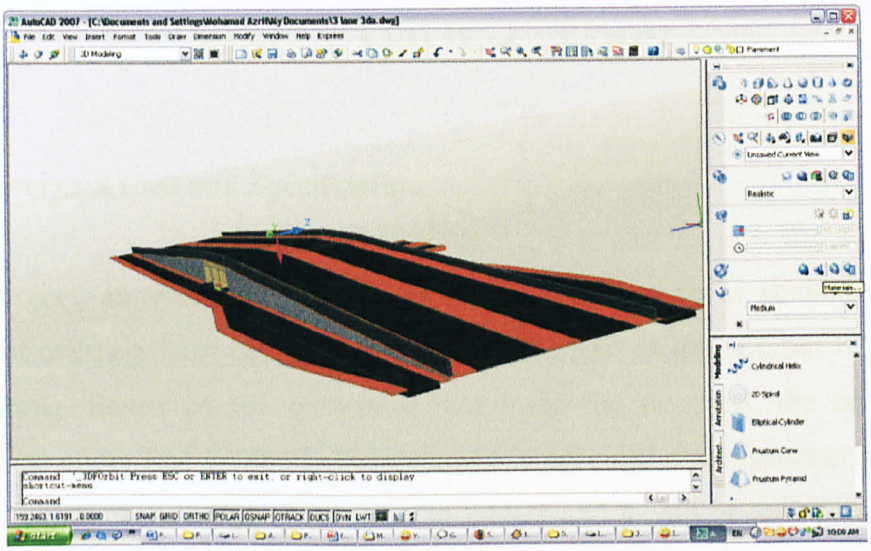

Figure 3.2: Drawing interface using the AutoCAD 2007

CHAPTER 4

RESULT AND DISCUSSION

4.1 Overpass Cost and Specification

In this project, an overpass location has been selected to be as studied site. The location of overpass have been selected was an overpass at Ipoh-Lumut Highway at Titi Gantung. Based on the contractor that build the overpass, the cost of the overpass are about RM 740 000. The overpass is provided with staircase and ramp. The span of the walk bridge 1 is about 30 meters and length of the staircase is 13 meter with two landing each. The height that user needs to climb to use the overpass is about 7 meters. The ramp is providing for motorcyclist and bicyclist to go up for crossing the road. The length of the ramp is about 82 meters. See Appendix 4.1 for structural details of the overpass. Figure 4.1 show the photo of the overpass at Titi Gantung cross the Ipoh-Lumut Highway.

Figure 4.1: Titi Gantung overpass

Based on the cost of the overpass, if the new design of grade separated pedestrian crossing could be construct with around that value it could be possible to apply the new design.

4.2 Pedestrian and Traffic Count Survey

4.2.1 Pedestrian utilization survey at Ipoh Lumut Highway, Titi Gantung

Surveys have been done at one of the selected studied site, Titi Gantung overpass. The survey objectives is to determine the characteristic and utilization of the people that crossing the road using the overpass or under the overpass. The survey was conducted on 15th of September 2008 between 1pm till 3 pm. The survey was conducted during end of school session where there are many school students went back and using the overpass. Some parents who are ride the motorcycle to pick up their children from school also use the overpass to cross the highway. During the survey we also observed the time that pedestrian, motorcycle and bicycle take to cross the highway using the overpass. The time is taken using the stopwatch. It takes from the moment the pedestrian step in to the stairs of overpass until step out from the overpass. The distance and difficulties that face by the pedestrian also been observed during the survey. The result of the survey show in Table 4.1, Table 4,2 and Table 4.3.

4.2.1.1 Result

Table 4.1: The pedestrian utilization on overpass result at Titi Gantung

category	No. of user crossing	
	Use walkbridge	Not use walkbridge
Pedestrian	70	1
Motorcyclist	84	2
Bicycle	9	2

Table 4.2: Time taken to cross using overpass at Titi Gantung

	Time taken (sec)		
	Pedestrian	Motorcyclist	Bicyclist
1	90	47	165
2	91	55	177
3	83	53	190
4	71	67	108
5	80	57	111
7	85	46	105
8		53	
9		68	
10		70	
11		40	
12		47	
average	83	54	142

Table 4.3: Vehicle Volume count result at Titi Gantung

	Traffic Volume	
	Ipoh - Lumut	Lumut - Ipoh
Class 1	149	182
Class 2	910	816
Class 3	388	244

Class 1: Motorcycle

Class 2: Car, van and SUV

Class 3: Pick-up, truck, bus and trailer

4.2.1.2 Discussion

Based on the result, the numbers of pedestrian using the overpass is higher than the pedestrian cross at the road level. The divider in the middle of the road that force pedestrian to use the overpass. Most of the pedestrian crossings using the overpass are student. The student may not take the risk to cross at the road level.

The survey on traffic volume count shows it is a heavy traffic flow. The volume of cars, lorry, trucks and bus has a high numbers. This could be risky cross for the pedestrian that intend to crossing without using any crossing facilities. If the pedestrian is hit by the vehicle could result to casualties.

When the pedestrian cross using the overpass, the time they take to cross is more than then crossing at the road level. This is due to the distance and the elevation of the path using the overpass.

4.2.2 Pedestrian Utilization Survey at Jalan Panglima Bukit Gantang Wahab, Ipoh

On 14 January 2009 a survey to assess the utilization of pedestrian on the overpass have been done. The survey was done at overpass on Jalan Panglima Bukit Gantang Wahab infront Sekolah Menengah Jenis Kebangsaan Poi Lam and near Perak JKR headquarters and Kompleks Islam Darul Ridzuan. The duration of the survey is from 10 am till 11 am. Figure 4.2 shows the location of the overpass.

Figure 4.2: Location of the overpass at Jalan Panglima Bukit Gantang

4.2.2.1 Result

The first survey starts with count the numbers of pedestrian that using the overpass or not using the overpass while crossing the road. The area covers 50m from the overpass. Any pedestrian crossing inside this area is taking count. The result as follow:

Table 4.4: Pedestrian utilization on overpass survey result at Ipoh

Type of crossing	Numbers
Use the overpass	16
Not use the overpass	112

During the survey, the time taken for pedestrian take to cross the road by using overpass or not have been taken. The time for pedestrian using the overpass is taken from the time their step into overpass stairs until their step out from the overpass. For pedestrian cross without using overpass is taken from the time their waiting at road shoulder (waiting the road clear from vehicle or safe to cross) and until their finish crossing at the other side of the road. The result as follows:

Table 4.5: Road crossing time taken result at Ipoh

Type of crossing	Average time taken
Overpass	1 minute 24 secs
Not Use Overpass	42 secs

4.2.2.2 Discussion

From the result it's shown that 88% of the pedestrian do not use the pedestrian overpass. Figure 4.3 show some of the pedestrian do not use the overpass at Jalan Panglima Bukit Gantang. Based on the observation the time that pedestrian take to cross road using overpass is longer than crossing. The difficulties for pedestrian to climb up the overpass to cross make them to take short cut by crossing at road level. The distance those pedestrians take also more than crossing at the road level. This makes the pedestrians more likely to cross without using the overpass.

From the observation also, it show that crossing at the road level is more dangerous and risky especially in busy road or highway.

Figure 4.3: Photo of pedestrian do not use the overpass at Jalan Panglima Bukit Gantang

CHAPTER 5

PEDESTRIAN FRIENDLY GRADE SEPARATED CROSSING

5.1 Introduction

The overpass structures seems not user friendly and gives difficulties for elderly, school student and disable people to use it. It gives more distance and time for people to use. That's why people often to cross at the road level.

The idea of Pedestrian Friendly Grade Separated Crossing it come from instead the pedestrian need to climb up to cross a road why just let the vehicles go over top of the pedestrian crossing.. This pedestrian crossing can be design not only for pedestrian but also for bicycle, motorcycle and vehicle. The overall view of Pedestrian Friendly Grade Separated Pedestrian Crossing concept show in Figure 5.1.

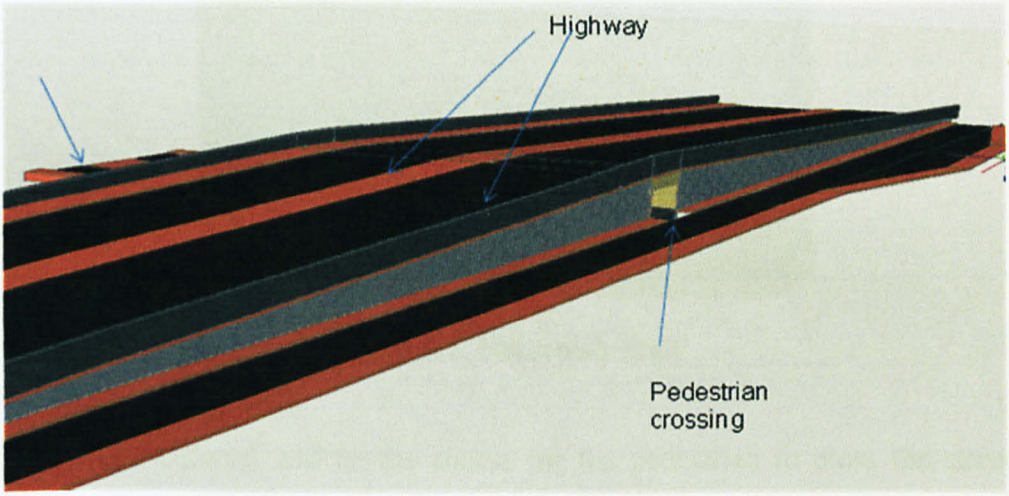

Figure 5.1: Overall view of Pedestrian Friendly Grade Separated Pedestrian Crossing

5.2 The Structures

The main structure of Pedestrian Friendly Grade Separated Pedestrian Crossing consist the embankment, Nehemiah wall and giant segmental box culvert.

An embankment is use to elevated the road. The embankment will constructed using suitable materials to provide adequate support to the formation and long-term stability. The side of the embankment is will be retain by Nehemiah wall (Figure 5.2).

The reasons for choosing the Nehemiah wall are because it's cost effectiveness, versatility, excellent performance, attractive appearance, and speed of construction. See Appendix 5.1 for Nehemiah wall information. The Nehemiah wall is applicable in a wide range of situations. It is ideal for fill situation which is true for most of the highway interchanges. Construction is rapid and the interference with the vehicular traffic is minimized due to the "erection from behind" method implemented.

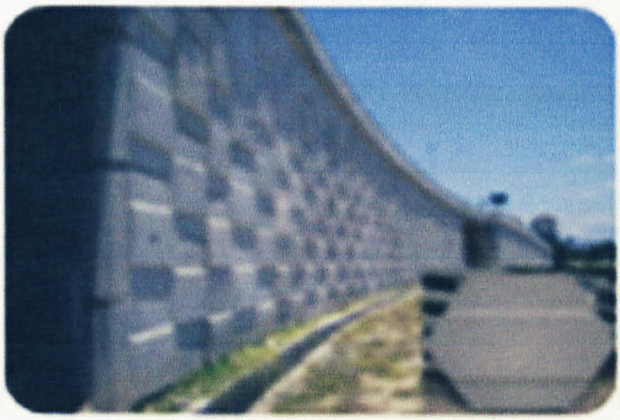

Figure 5.2: Nehemiah Wall

A tunnel (box culvert) will be the access for the pedestrian to cross the street. It would be like a tunnel across the embankment. Based on the JKR standard the minimum clearance height would be 2.5m, see appendix 5.2. With this crossing

pedestrian doesn't need to change their elevation when crossing the road. See Appen3ix 5.3 for Giant Segmental Box Culvert information.

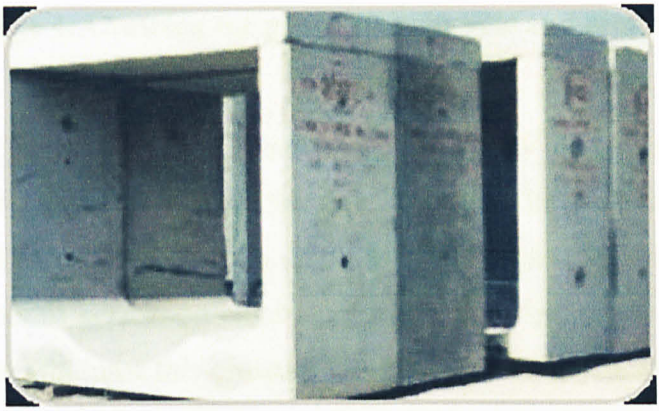

Figure 5.3: Giant Segmental Box Culvert

The reasons of choosing the Giant Segmental Box Culvert are:

- Low cost of installation compared with cast-in-place twin cell Vehicular Box Culvert.
- Minimized traffic obstructions, reduced construction time.
- Easy to transport, handling and installation.
- Have manageable unit weight(4-9 tons)
- Have good quality, produce by factory to stringent standards.

5.3 Design Type

There are two type of design that proposed for this project, which are

a) Crossing only for pedestrian and
b) Crossing for pedestrian with vehicles (for vehicle below 2.5m)

The design of these two types of crossing is based on the studied site of overpass at Ipoh-Lumut Highway, Titi Gantung. The overpass infront of Sekolah Kebangasaan

Titi gantung. The proposed design of the new grade separated crossing is design to replace the existing overpass.

5.3.1 Type 1: Crossing for pedestrian, bicycle and motorcycle

This first type (Type 1) only can be access or use by pedestrian, bicyclist and motorcycle. This is simplest design for this crossing. The road is elevated by the embankment and cross the pedestrian crossing tunnel which construct using the box culvert. The tunnel of pedestrian crossing is located in front of the school gate. The student/pedestrian who uses this crossing will go in to the school by the middle gate of the school. The other two side gate is for vehicle to go in and to go out (Figure 5.6). The plan view of the crossing and vehicles flow show in Figure 5.7.

The width of the tunnel would be 3 meter (also based on size of the box culvert) to give space between the pedestrian and cyclist in the two direction. Figure show the plan view and side view of the crossing (Figure 5.5). Based on JKR Basic Guideline on Pedestrian Facilities a height clearance of at least 2.0 m should be provided. Adequate width should be provided. This may vary from a fixed minimum of 0.9 m to 2.4 m or wider in high pedestrian activity areas (see appendix 5.4).

The height of the embankment wills about 3 meters show in figure5.5. With the design speed of the highway is 100 km/h and gradient of 5% based on JKR Guide on Geometric Design of Roads (see appendix 5.5), the length of the embankment should be about 120 meters, its show in Figure 5.4.

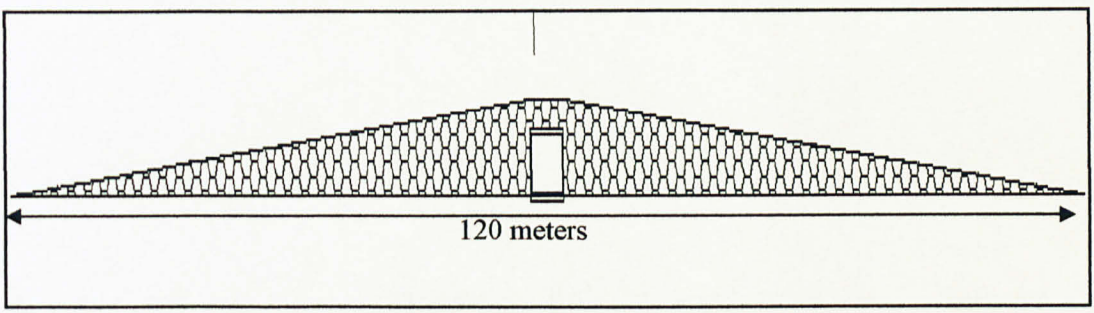

Figure 5.4: Length and side view of the embankment for type 1 crossing

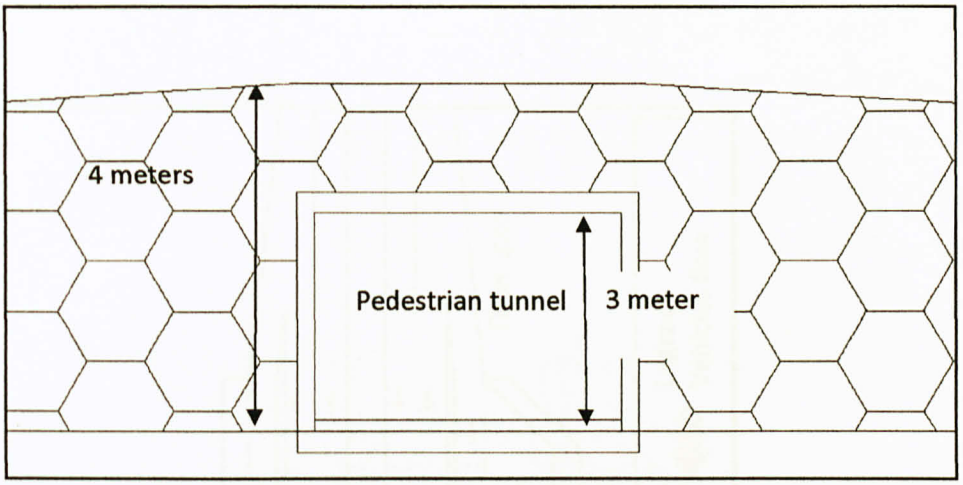

Figure5.5: Pedestrian tunnel height and embankment height for type 1 crossing

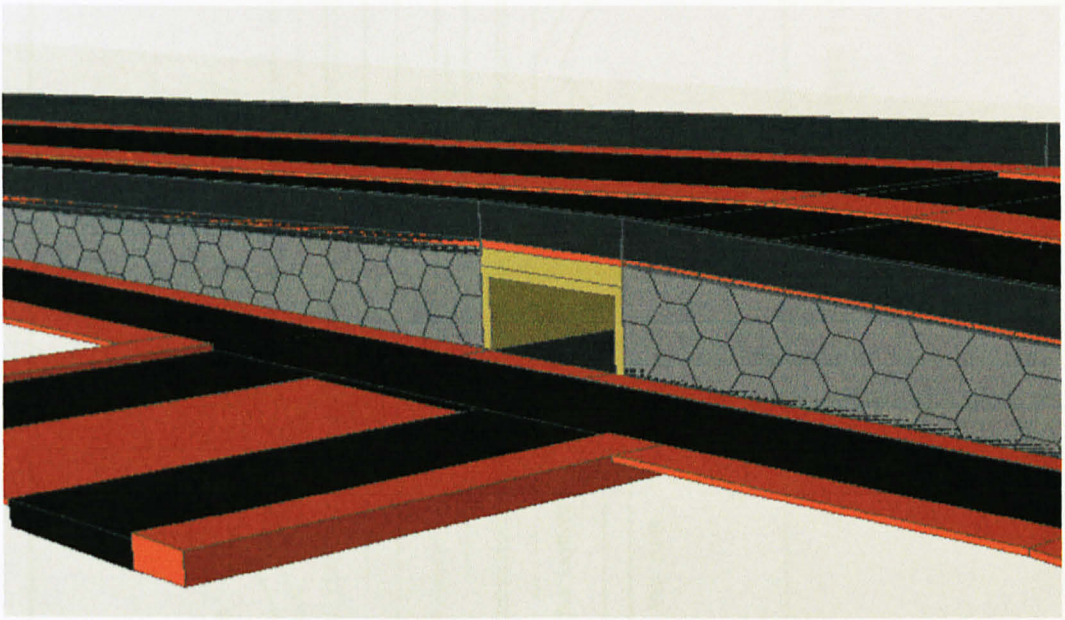

Figure 5.6: 3D view of Type 1 Crossing

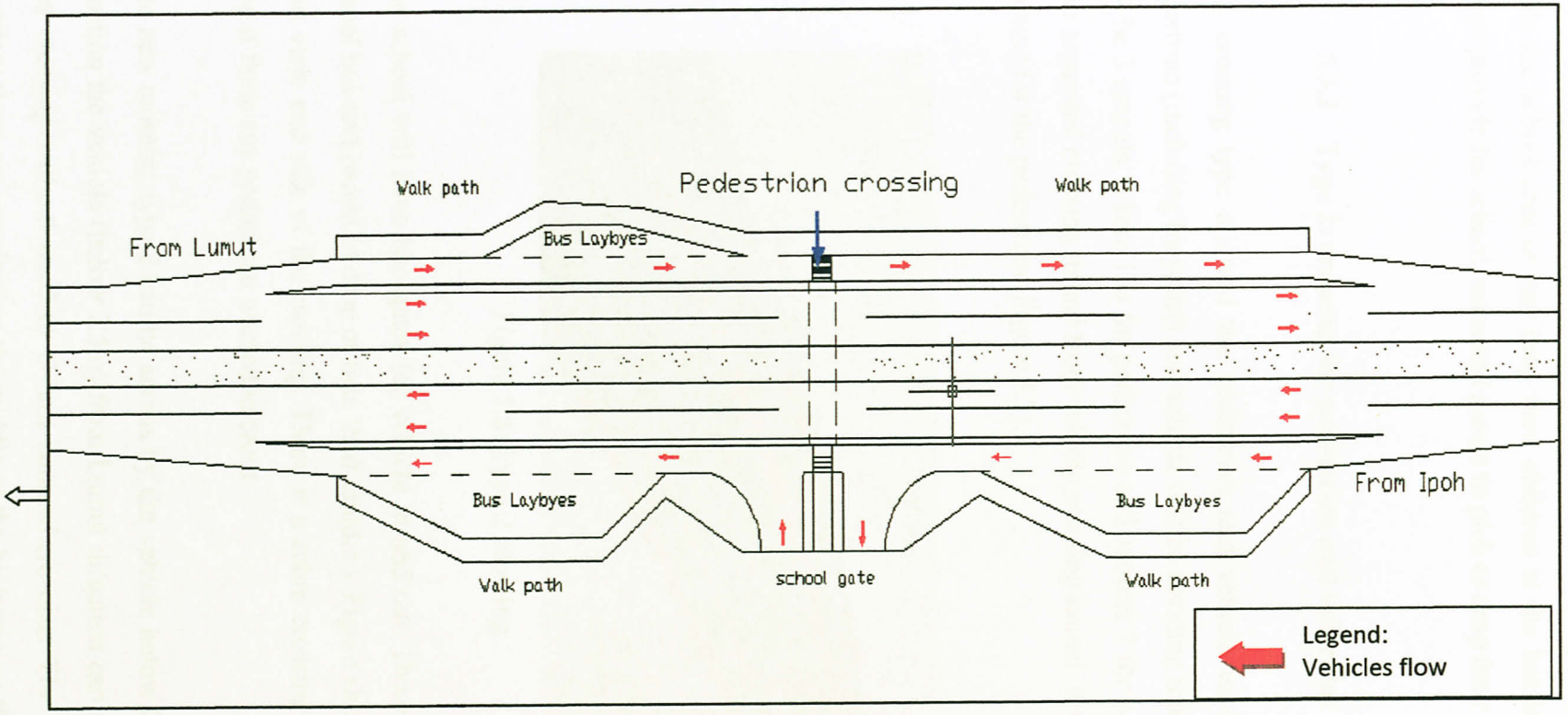

Figure 5.7: Plan view of the type 1 crossing

In the type 1 design, the vehicle comes from Ipoh who wants to the school or sent their children can have an exit to the school from the highway. The vehicle can go inside the school area or just drop their children at the bus laybye. There are two laybye provide for school buses and parent to pick or drop their children.

5.3.2 Type 2: crossing for pedestrian and vehicular (height below 2.5m)

This crossing type allowed the pedestrian and vehicle to use. In this type the pedestrian (including bicyclist) and vehicle will be dividing into different lane. There will be 3 tunnels, where 1 is for pedestrian and another 2 for vehicle. The pedestrian have separated crossing tunnel from vehicle crossing tunnel. It will make more safety crossing for the pedestrian (Figure 5.7).

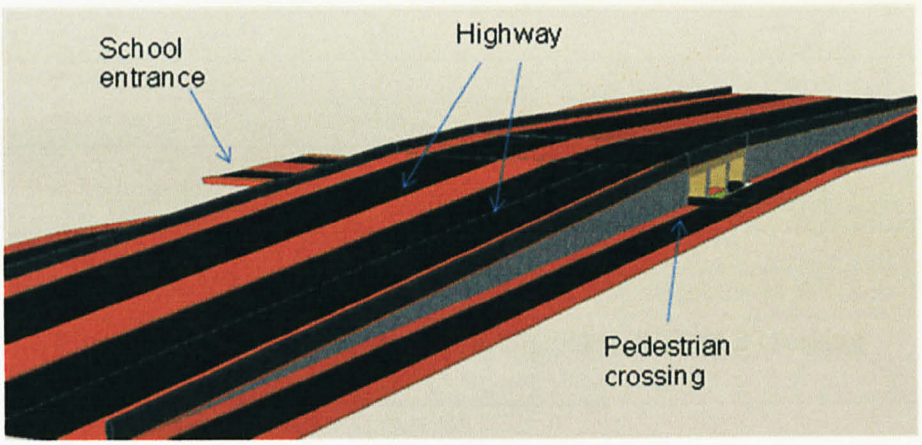

Figure 5.8: Type 2 crossing

The school will have two gates for vehicle in and out. There will bus lay byes for school bus and parent to drop or take their children. Figure show the flow of vehicle, plan view and side of the crossing. There is a zebra crossing where vehicle should stop if there any pedestrian wanted to cross.

The new crossing type 2 can be access by the vehicle below 2.5m height. With this function the vehicle (below 2.5m) from Lumut direction can go to the school using this crossing without need to U-turn somewhere else. The current design of the overpass there are guardrail in the middle of the highway, so the vehicle from Lumut

direction can't directly turn to go to the school. The vehicle from school who want go to the Ipoh direction can use this crossing and then take the Ipoh direction on Ipoh –Lumut Highway. If not the vehicle also need to U-turn somewhere else at Lumut direction before turn back to Ipoh direction. This crossing allowed the vehicle use for U-turn for both directions. Traffic flow details refer to Figure 5.8.

The height of the embankment of this type 2 crossing is 3.5 meters. The length of the embankment is about 150 meters with 5% gradient for 100km/h design speed. The length of the tunnels is about 22 meters each.

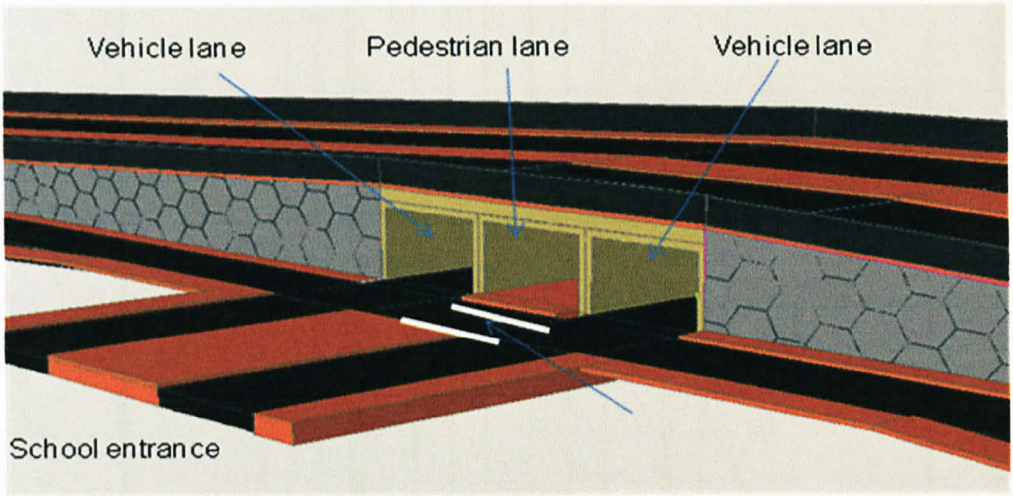

Figure 5.9: Vehicle lane and pedestrian lane in Type 2 crossing

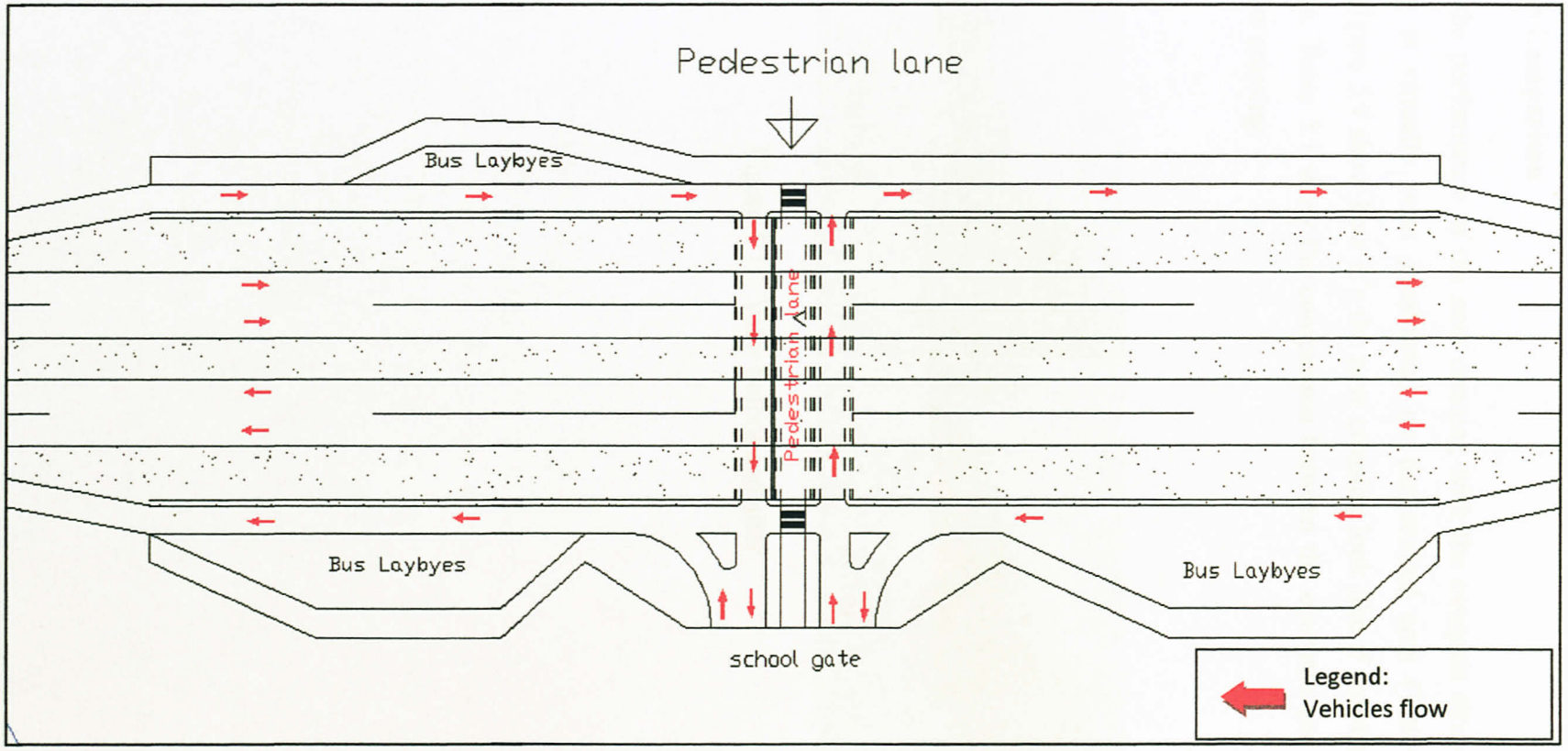

Figure 5.10: Plan view of Type 2 crossing

5.4 Design Comparison

To compare the performance of the new crossing with the overpass structure, the new crossing is virtually been constructed on the studied area (Titi Gantung Overpass). Figure 5.9 show how it's the new crossing look like if construct it the particular area. Table 5.1 show the comparison between the overpass and the two type of the new crossing.

Figure 5.11: View before and after

Table 5.1: Comparison table of overpass, new crossing type1 and type2

		Overpass	Type 1	Type 2
Time taken (sec)	Pedestrian	83	20	20
	Motorcyclist	54	10	10
	Bicyclist	142	7	7
Accessibility		Pedestrian, Bicycle and Motorcycle	Pedestrian, Bicycle and Motorcycle	Pedestrian, Bicycle, Motorcycle, Vehicle below 2.5 m height
Vertical movement		6.8 m	No	No
Crossing distance (m)	Pedestrian	52.6	30	30
	Motorcyclist	190.8	30	30
	Bicyclist	190.8	30	30
Estimation of cost (RM)		740 000	838,764	997,984

From the table 5.1 shows that the time taken that pedestrian took to cross the highway with new crossing is less than overpass. The time different between the two crossings for pedestrian are 63 sec. This is due to the distance and vertical that user takes to cross the highway. For the overpass pedestrian need to use stair to climb up for crossing while the bicycle and motorcycle need to use the ramp. So it does approve that this new crossing will shorten the distance and time for crossing.

For accessibility, overpass and new crossing type 1 can only be access by pedestrian, bicycle and motorcycle. Nothing different with this two crossing in term accessibility but as been discuss before the new crossing will give shorten crossing distance and time. The new crossing type 2 has an extra function, where it can be access by the vehicle below 2.5m height (Figure 5.10).

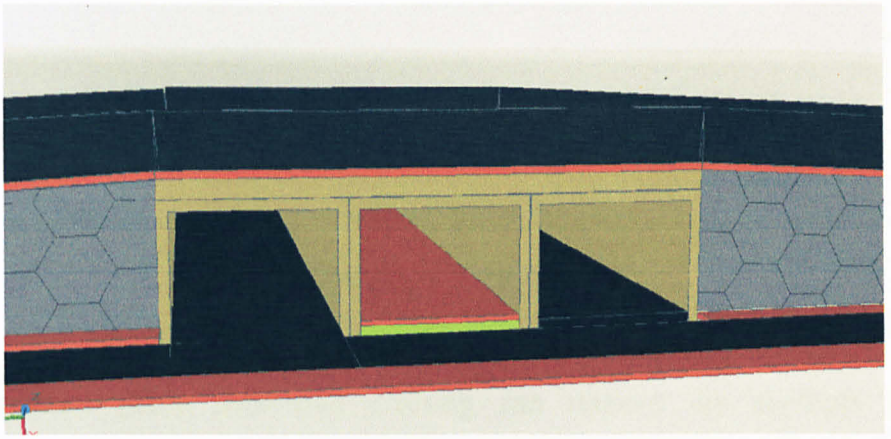

Figure 5.12: Pedestrian tunnel (center) and vehicle tunnel at both sides in type 2 new crossing designs.

For the new crossing the pedestrian doesn't need to have the vertical movement. It's mean that the pedestrian doesn't need to go up or to go down to cross the highway. The overpass structure needs the pedestrian to take stairs to climb up to 6.8m above the road level. This height is very difficult to elderly and disability people. With the new crossing can be access by all range of pedestrian and make it user friendly.

With this friendly type of crossing, it will make pedestrian likely to use it then it can remove the conflict between pedestrian and vehicle. With this design is capable to make 100% of pedestrian that cross in that area use this crossing. Hence, it can reduce the accident between the pedestrian and vehicle.

The cost of the new grade separated pedestrian crossing quite expensive than overpass but it more user friendly than overpass. To have more safety, friendly and better crossing

CHAPTER 6

CONCLUSION

The separated grade pedestrian crossing can remove the conflicts between pedestrians and vehicles at the intersection. However, grade separation increase the walking distance and time. This led the pedestrian to cross at the road level which crossing in the unsafe condition. For the children, elderly and disable people the grade separation is inconvenience in the elevation change of grade separated. To overcome this problem a Friendly Pedestrian Grade Separated Pedestrian Crossing need to be design. The idea is instead let pedestrian to go above the road to cross, now let the vehicle go above the pedestrian while pedestrian can cross at road level.

With this Friendly Pedestrian Grade Separated Pedestrian Crossing it makes the pedestrian to use it because it is friendlier, less distance and less time crossing compare to the overpass. This can decrease the rate of pedestrian that cross without proper crossing. The extra features that can give the vehicle below 2.5m height use this crossing can make the school easy to be access.

From the pedestrian survey at Ipoh we can see that if the pedestrian using overpass to cross its take about 1 minute 24 sec and without use it take time 42 sec including waiting time for road to safe to cross. If the pedestrian can cross without obstacle it can cross less than 20 sec. So Pedestrian Friendly Grade Separated Pedestrian Crossings can give this time of crossing.

The value to construct the overpass at Titi Gantung is about RM 740 000 compare with the new crossing so different but the design of the overpass is not very convenient. So it is possible to construct Friendly Pedestrian Grade Separated Pedestrian Crossing in the future.

CHAPTER 7
RECOMMENDATIONS

This design project focus on overpass at highway area, for next continuation can be working on overpass at urban area. Where there are a lot of overpass located at the middle of the city to cross the busy road. This is quite challenge to design a Pedestrian Friendly Grade Separated Pedestrian Crossing in the city due to the limited space in the city.

For the continuation of this project, several aspects can be done to improve the outcome of this project. Design detailed like design calculation can be done in the future. To done the design calculation data like soil profile need to be obtained. With design detail the cost of the project can be estimate accurately.

From this project there are several aspects that can be improved for future research especially in material. It's being required to have a well-built and cost effective material. This could decrease the cost of the project. Most of the project the cost is one of the important warrants to construct the project.

Besides that for continuation of this project, it will be better to studied on the effect of vehicle to this new crossing. This is including studies on fuel consumption, sight distance effect and time taken by the vehicle.

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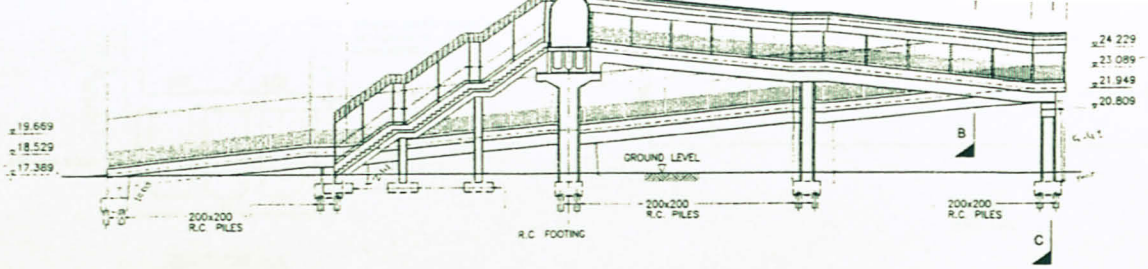
APPENDICES

Appendix 4.1:

Titi Gantung Overpass Detailed



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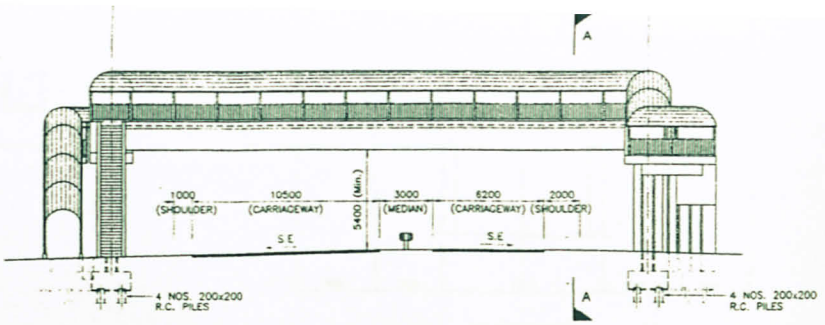

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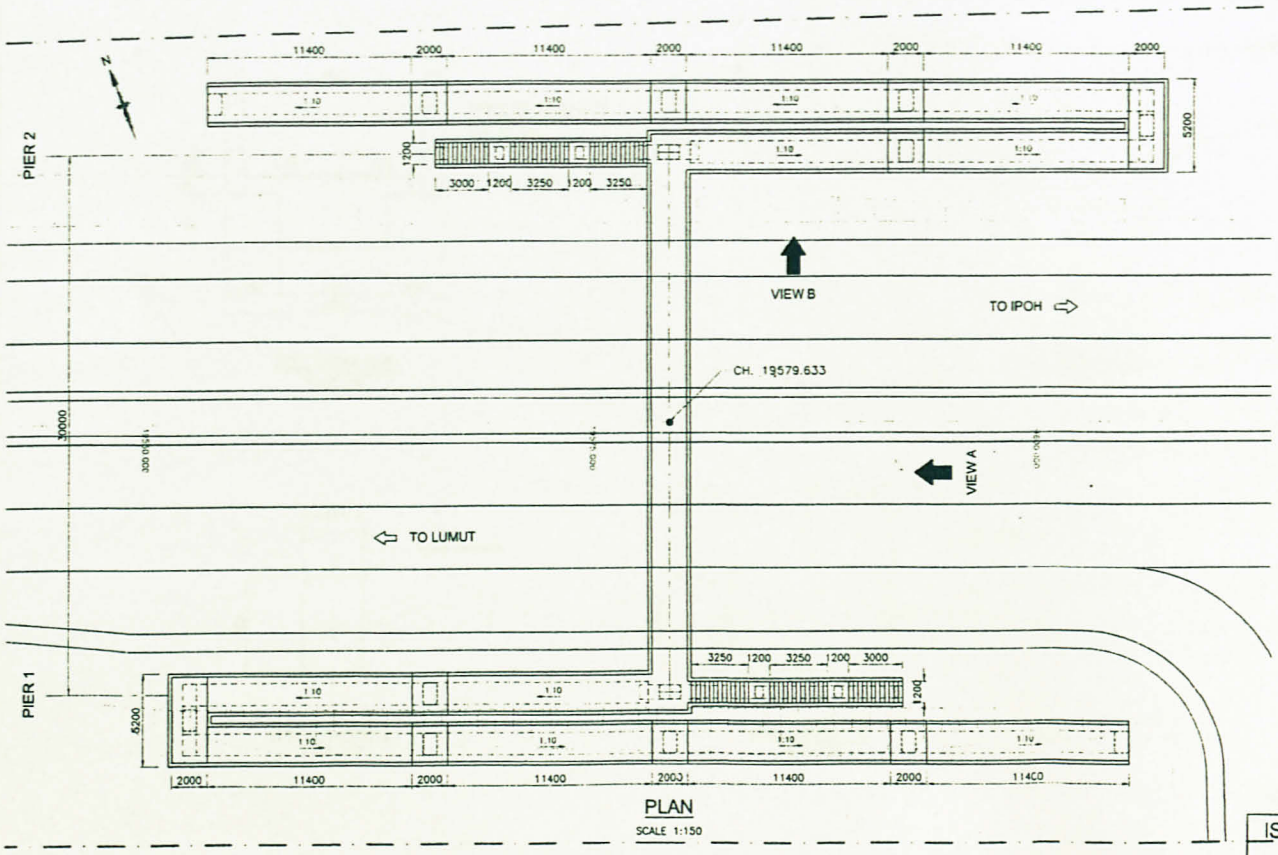

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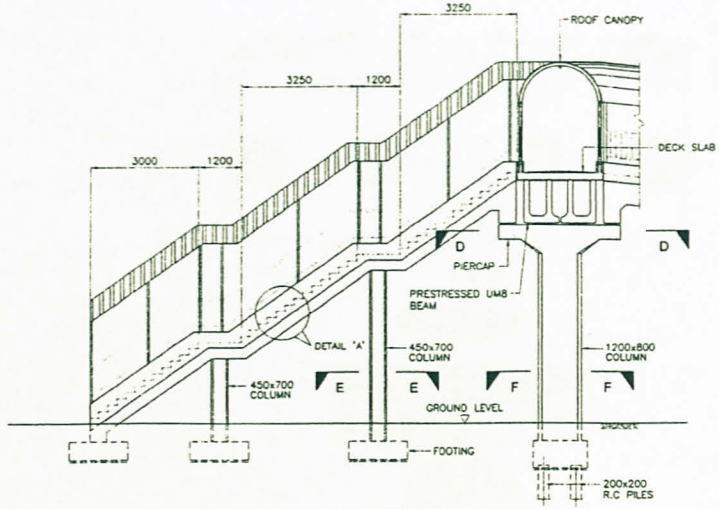

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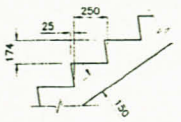

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2. ALL REDUCED LEVELS AND CHAINAGES ARE IN METRES.
3. ALL REDUCED LEVELS ARE TO BE VERIFIED BEFORE CONSTRUCTION.
4. ALL CHAINAGES AND LEVELS ARE TO BE READ IN CONJUNCTION WITH RELEVANT ALIGNMENT DRAWINGS AND CONFIRMED ON SITE.

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PEMILIK: JABATAN KERJA RAYA MALAYSIA
CAWANGAN JALAN

TAJUK PROJEK: CADANGAN MENAIKTARAF LALUAN PERSEKUTUAN 5 DARI IPOH KE LUMUT
PACKAGE 1 : PEDESTRIAN CROSSING AT CH. 19579.633
GENERAL ARRANGEMENT (SHEET 1 OF 2)

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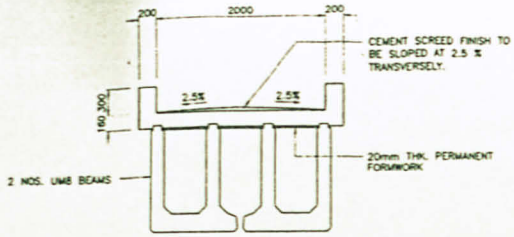

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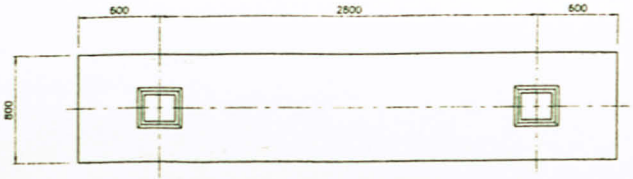

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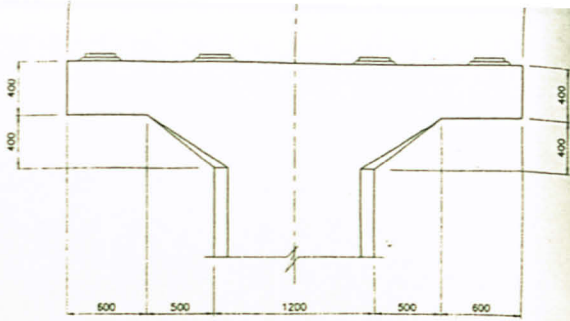

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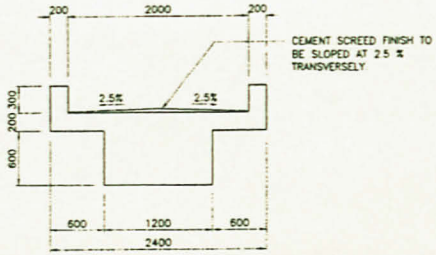

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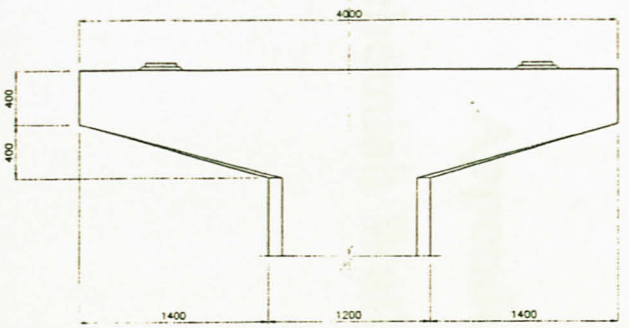

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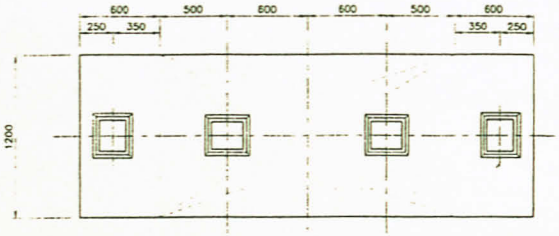

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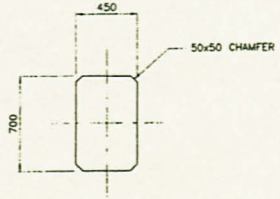

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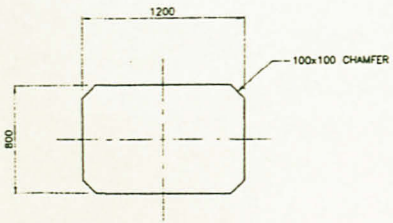

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SAYA BERTANGGUNGJAWAB SEPENUHNYA KE ATAS KESELURUHAN REKABENTUK DAN PRESTASI PROJEK INI

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NOTES :
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BIL. HELAIAN:

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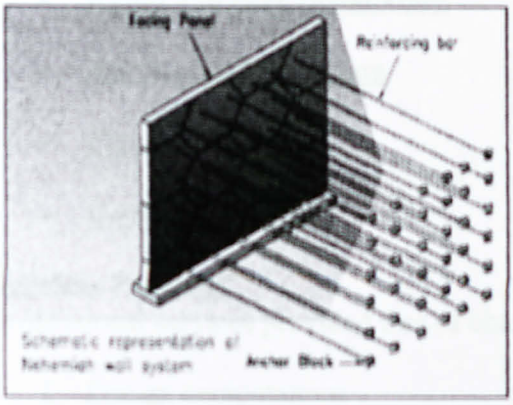
Appendix 5.1:

Nehemiah Wall Information

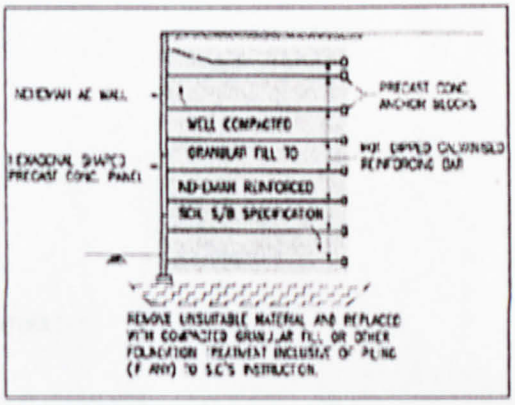
Nehemiah Wall is type of reinforced soil system based on Anchored Earth® concept where by the mode of stress transfer from the backfill to the reinforcement is by passive resistance in addition to friction. This System is reinforced by galvanised steel bars and anchored by precast concrete blocks. The facing is vertical consisting of modular hexagonal shaped concrete panels interlocked together.

The schematic representation of Nehemiah wall is as shown below. The system consists of three major components namely the facing, the reinforcing bars and anchor blocks.

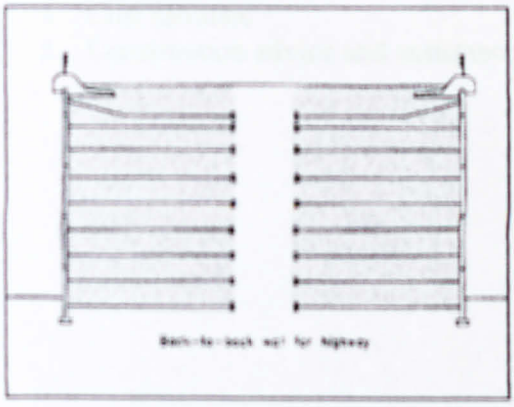
- **Facing Panel**
- **Reinforcing Bars**
- **Anchor Blocks**



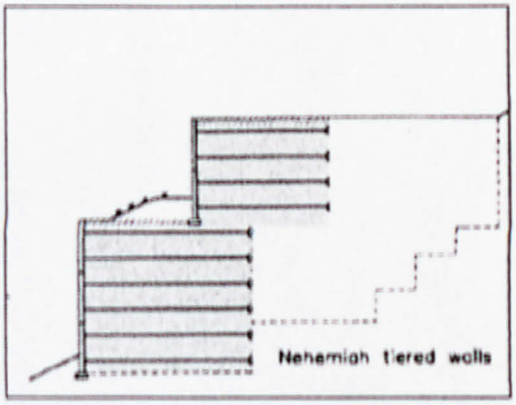
Schematic representation of Nehemiah wall Systems



Typical Section of Nehemiah Wall



Back-to-back Wall for Highway



Nehemiah tiered Wall

The system is ideal for

- Urban highway interchanges
- Mountainous Highways
- Railway embankments
- Bridge abutments
- Housing retaining walls
- Marine walls
- Rivers walls
- Secondary containment dykes
- Military walls

Advantages

Nehemiah wall is the chosen technology because of the following advantages :

- **Cost Effectiveness**
- **Rapid and easy Installation**
- **Aesthectically pleasing**
- **Flexibility**
- **Durable**

Services Provided

Professional services provided free of charge are as follows :

1. Design computations
2. Construction drawings
3. Material and construction specification
4. Cost estimate
5. Construction advice and assistance

Appendix 5.2:

Minimum Clearance Height

5.0 INTERSECTION TREATMENT

At intersection or interchanges, some form of channelisation with specific routes for the motor cyclists should be provided to minimize conflicts that will arise. Possible intersection treatment types include i) at grade or ii) grade-separated.The type of intersection treatment will depend on the volume of the traffic and the volume of motorcycles.

5.1 At Grade Intersection Treatment

An at-grade intersection treatment is sufficient where the volume of motorcycles does not exceed 30 percent of the total volume of traffic at the particular intersection during peak hours. Typical at-grade intersection is as shown in Figure 4(a) and 4(b). An at-grade intersection treatment is sufficient with proper signing, speed limits and lane markings.

5.2 Grade Separated Intersection Treatment

When the volume of motorcycles exceeds 30 percent of the total volume of traffic at the particular intersection during peak hours or when an at-grade intersection treatment does not provide a smooth flower adequate safety to the motorcyclist, grade separated intersection treatment should be considered.

This can be easily incorporated at roundabout and other intersections with the provision of underpasses (box culvert type).

The underpass must have a 2.5m clearance with a maximum slope of 10 percent. They should be lighted to give better visibility and safety during the night time. A typical, underpass is as shown in Figure 5.

6.0 DRAINAGE

No special drainage treatment is required for a shared or restricted cycle track forming part of an existing carriageway. In steep sloping terrain where it is necessary for the cycle track to be cut into the hillside, a continuous gutter should be provided along the cut face with approximately placed sumps and drains to divert storm water run-off beneath the cycle track.

Appendix 5.3:

Giant Segmental Box Culvert Information

Giant Segmental Box Culverts (GSBC) bridge the gap between standard box and pipe culverts, and conventional bridge applications

ADVANTAGES

1. Lower cost of installation compared to cast-in-place twin cell Vehicular Box Culvert.
2. Reduced construction time, minimised traffic obstructions.
3. Ease of transportation, handling and installation.
4. Smaller cranage capacity.
5. Comes in manageable unit weight (4-9 tons).
6. Provides better flaw area per concrete material used.
7. Very stable structure during handling and erection stages (aspect ratio, Height/Width ≥ 3).
8. Site progress less affected by adverse weather conditions.
9. Factory produced to stringent standards
10. Without a central wall, allows free flow which does not collect debris.

APPLICATIONS Drainage channels, vehicular and pedestrian underpasses, highways, bridges, river crossings, utility tunnels, subway lines, railway crossings, canals, garages, motorcycle underpasses, etc.

Hydraulic Considerations

GSBC is able to accommodate a very large waterway area within a single cell. With its huge hydraulic capacity, it can replace normal multicell structures with a single cell structure.

Some applications areas :

1. Drainage channels
2. Canals
3. River crossings

Structural Considerations

The versatility of the GSBC technology is showcased here as structures that can be constructed as:

1. Vehicular and pedestrian underpasses
2. Highway bridges
3. Utility tunnels
4. Subway lines
5. Garages
6. Motocycles underpasses
7. Railway crossings

GSBC therefore offers varied applications in terms of size, strength, flexibility and offers easy and quick construction.

TYPES AND SIZES

1. Hume's GSBC units are available in nominal widths of 4.2 meters and 4.8 meters with heights from 2.4 meters to 4.2 meters and 4.8 meters respectively, at intervals of 600mm and lengths of 1 meter.
2. Hume's GSBC units come with a "specially designed" Dry Weather Flow, which has a gentle slope to the middle of the GSBC invert base.

HANDLING & INSTALLATION

Lifting holes (weep holes) are provided at the box culvert wall. It is recommended that a spreader beam be used when slinging the invert to minimise handling stresses.

TRANSPORT

Hume's GSBC, units can be easily transported to sites with proper handling equipment.

JOINTING

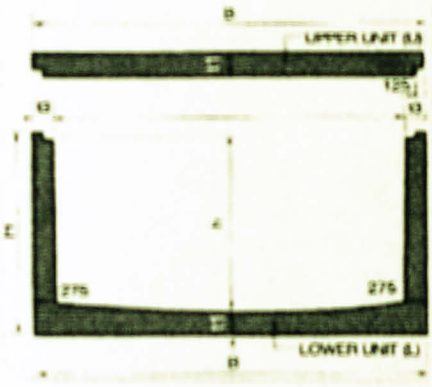
Hume's GSBC units are supplied with rebated joints with protruding dowel rods from the lower unit to be joined in a recess on to then upper unit. A 20mm diameter grouting hole is provided for the upper unit to facilitate the grouting procedure.

DESIGN CONSIDERATIONS AND SPECIFICATIONS

1. Design loading requirements for Giant Segmental Box Culvert (GSBC) are in accordance with :
   BS 5400 : Part 2 : 1378 modified by (b).
   Department Standard ED 31/87, Buried Concrete Box Type Structure, issued by Department Transport (UK) Highway and Traffic.
   JKR LTAL (Long Term Axle Load) and SV (Special Vehicle) requirements.
2. Reinforced concrete design in accordance with BS 5400 : Pt.4, 1984.
3. Concrete characteristic strength at 28 days, fcu = 30 Mpa - 40 Mpa.
4. Concrete cover to reinforcement for GSBC = 30mm.
5. Soil parameters used in design :-
6. Coefficient of the earth lateral pressure at rest = 0.5, bulk density of soil = 19 kN/m3
7. Hume's GSBC also complies with proof test load criteria with 2 nos, of 112.5kN loads over an area of 500mm x 150mm, spaced at 1.8meter intervals, placed at any position on the upper unit of the box culvert.

8. Hume's GSBC is designed to cater for backfill superimposed dead load not exceeding 4 meters depth (inclusive of pavements) plus 45 units of HB vehicle primary live loads.
9. Hydrostatic pressures are eliminated by the provision of a series of 50mm diameter weep holes placed along the centerline of the invert wall.
10. GIANT SEGMENTAL BOX CULVERT **Table 1**

GSBC WITH FLAT LID

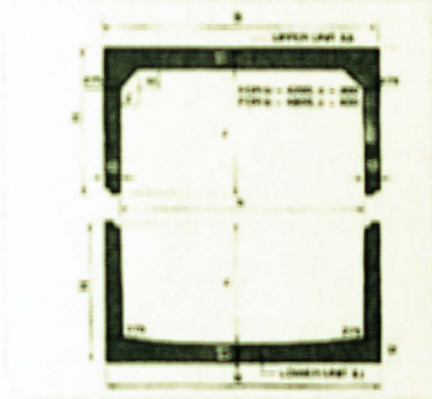


CROSS SECTION VIEW (REFER TO TABLE 1)

TYPE	LABEL	b	h	B	H	t1	t2	t3	WEIGHT (ton)	
									Unit	Total
4200 x 2400	U4200	4200	N.A.	4700	N.A.	300	N.A.	N.A.	3.4	10.07
	L4224	4200	2400	4700	2675	275	400	250	6.67	
4800 x 2400	U4800	4800	N.A.	5300	N.A.	325	N.A.	N.A.	4.16	11.72
	L4824	4800	2400	5300	2700	300	450	250	7.56	

11. **Table 1**

GSBC WITH INVERTED-U LID



CROSS SECTION VIEW (REFER TO TABLE 2)

TYPE	**LABEL**	**b**	**h**	**B**	**H**	**t1**	**t2**	**t3**	**WEIGHT (ton)**	
									Unit	**Total**
4200 x 3000	U4206	4200	600	4700	900	300	N.A.	273	4.48	11.15
	L4224	4200	2400	4700	2675	275	400	250	6.67	
4200 x 3600	U4212	4200	1200	4700	1500	300	N.A.	265	5.14	11.81
	L4224	4200	2400	4700	2675	275	400	250	6.67	
4200 x 4200	U4218	4200	1800	4700	2100	300	N.A.	250	5.87	12.54
	L4224	4200	2400	4700	2675	275	400	250	6.67	

4800 x 3000	U4806	4800	600	5300	925	325	N.A.	273	5.42	12.98
	L4824	4800	2400	5300	2700	300	450	250	7.56	
4800 x 3600	U4812	4800	1200	5300	1525	325	N.A.	265	6.2	13.76
	L4824	4800	2400	5300	2700	300	450	258	7.56	
4800 x 4200	U4818	4800	1800	5300	2125	325	N.A.	250	6.97	14.53
	L4824	4800	2400	5300	2700	300	450	250	7.56	
4800 x 4800	U4824	4800	2400	5300	2725	325	N.A.	250	7.71	15.27
	L4824	4800	2400	5300	2700	300	450	250	7.56	

Appendix 5.4:

Pedestrian Lane Width

sation of any grade separated pedestrian crossing facility.

- The provision of steps (stairs) rather than ramps at pedestrian grade separations has been found to be a discouragement to pedestrians.
- Where subways are depressed below ground level, are long and not well lighted, personal security can be a perceived problem, particularly for women, children and elderly people. Such facilities often experience poor utilisation even in daytime.

Warrants And Layout Guidelines

Consideration of the various factors relevant to the choice of the appropriate type of pedestrian crossing leads to the presentation of a range of different types of facilities to suit various classes of road and different road environment situations. Most of the 'well proven' techniques and devices are currently being used in Malaysia, but the main problem is that particular treatments are often used at inappropriate locations and the geometric design, traffic signing and roadmarking vary greatly from site to site.

Guidelines for the selection of the most appropriate type of treatment are provided in Figure 1. The desirable general layout etc for various types of pedestrian crossing facilities are illustrated in Figures 2 to 7.

In the absence of quantitative and other guidelines specifically developed for Malaysian conditions, it is suggested that those presented in the AUSTROADS (Australia) Guide To Traffic Engineering Practice, Part 13 - Pedestrians, (derived from Australian Standard AS 1742. 10), be adopted as 'Interim Guidelines' until such time as experience in practice indicates any necessary changes to better suit Malaysian conditions. These are attached as Appendix A of this report.

Provisions For Pedestrians At Signalised Intersections

At intersections where traffic signals are installed to control conflicting traffic movements, the provision of special signal heads (faces) and signal phases to assist pedestrians to cross safely can be incorporated at little additional cost. In general, at important intersections within cities and towns, there will usually be sufficient pedestrian movements to justify the provision of pedestrian facilities, not withstanding this, some guidelines / warrants for such provisions are included in Appendix A.

The type of pavement marking to be used to indicate the pedestrian crossing at signalised intersections is similar to that used at signalised pedestrian crossings away from intersections ie, conventional signalised pedestrian crossings as illustrated in Figure 5. These consist of white transverse lines marked across the carriageway the width between which may vary from a minimum of 2.5m (for low pedestrian flows) to 4 m (for high pedestrian flows). Note that Zebra type markings must not be placed across the main carriageways at signalised intersections.

The pedestrian phases at signalised intersections are usually incorporated into the signal cycle in parallel with non-conflicting, or the least conflicting traffic movements. It is generally accepted that conflicts between left turning traffic is acceptable except where high speed 'slip' road with 2 or more traffic lanes are provided. At signalised intersections with significant pedestrian movements, 'Zebra' type pedestrian crossings may be installed across any separate left turn 'slip' road, but never in conjunction with a signalised left turn 'slip' road. It is also generally acceptable to allow the conflict between right turn vehicular traffic and pedestrians crossing the roadway into which the right turners are entering, except where this traffic movement is proceeding on a green arrow signal.

Guidelines For Providing Facilities For Pedestrians To walk Along Roads:

There are few places on the road system where no provision needs to be made for pedestrians to walk along a road, and in view of the vulnerability of pedestrians in any conflict with vehicles (including motorcycles) some form of segregation is desirable. However where the intensity of

land use and thus pedestrian movements are low , such as in most rural areas, the road shoulder can adequately provide space for people to walk clear of vehicular traffic.

While no numeric warrants are given for the provision of footpaths along roads, they are generally considered necessary in all "built-up" areas and may also be necessary at some rural locations such as in the vicinity of schools, mosques or other community facilities where pedestrians are likely to be concentrated.

In some city and town situations, on 'local street' class of roads, where there may be very high pedestrian activity, the roadway itself. These situations in which vehicles and pedestrians share the road carriageway require specific traffic rules which give pedestrians equal priority to vehicles together with special traffic management arrangements, including a maximum speed limit of 25 km/h or less, to reduce the degree of threat to pedestrians posed by vehicular traffic. In some countries these are referred to as "Shared Zones".

Where footpaths are provided. consideration should always be given to the needs of elderly people and people with disabilities. The design should incorporate the following characteristics aimed at making them 'user friendly' for all classes of pedestrians:

- Adequate width should be provided. This may vary from an absolute minimum of 0.9 m to 2.4 m or wider in shopping and other high pedestrian activity areas.
- A height clearance of at least 2.0 m should be provided.
- The pathway should not be obstructed by posts, poles, traffic signs, trees and other street furniture. Neither should they be allowed to be obstructed by adjacent business activity or parked vehicles, or unreasonably obstructed by motorcycles and bicycles. Any obstacle close to the pathway which could endanger pedestrians, particularly people with impaired vision, should be well delineated.
- Manhole covers and gratings, if they cannot be avoided, should be kept flush with the footpath surface and any drains close to the footpath, which could pose a danger to pedestrians, should be covered.
- Clearance of at least 1.0 m should be provided between the traffic lanes and the footpath.

  This clearance, which should be greater where traffic volume and, or speed are high, increases the safety of pedestrians, and reduces the inconvenience / annoyance caused by the splash from vehicle tires in wet weather.
- Changes in level along and beside the foot path should be minimised. Where it is not possible to avoid steps, particular care needs to be taken to properly identify them so that they can be seen, especially by people with impaired vision.

  Where differences in level are catered for by a ramp instead of or in addition to steps, the gradient should not be steeper than 1 in 10. Where long ramps are involved, such as at pedestrian bridges, gradients of 1 in 20 to 1 in 33 should be provided.

  Where kerbs are provided at the edge of the carriageway, they should not be higher than 150mm. Where the footpath crosses or intersects the kerb as at intersections and drive - ways, the kerb should be 'dropped' and a ramp at an acceptable slope should be provided.

  In general driveways should not 'cut' the footpath but should be ramped up or down from roadway level to meet the footpath level. The need for pedestrians to step down to the driveway level and back up to footpath level at each driveway is a major discouragement to pedestrians using the footpath. In addition. pedestrians should be given 'right of way' (priority) over vehicular traffic where drive ways cross the footpath. This pedestrian priority is greatly enhanced if vehicular traffic is ramped up to footpath level.
- Footpath surfaces should be firm. even. smooth and skid resistant, especially in wet

conditions.

Conclusion

Pedestrian movement forms part of almost every trip made on the road system and thus Pedestrians form an important component of the traffic sN-stem. The vulnerability of pedestrians, when they must operate amongst vehicular traffic, is amply emphasised by the high number of traffic accident casualties involving pedestrians. The lack of proper provisions for pedestrians to cross roads or to walk along roads safely is a major contributing factor to the high number of pedestrian casualties on Malaysian roads. Consideration of the specific needs of pedestrians must be made an essential part of the planning, design, construction, maintenance and operation of every road or road project. These guidelines should be used as a means of achieving better and more consistent standards and practices in relation to creating a more 'user friendly' and safer road environment for pedestrians.

	FUNCTIONAL CLASS / LEGAL CLASS				
	Expressway	Primary Arterial	Secondary Arterial	Collector Road	Local Road
TYPE OF PEDESTRIAN FACILITY	Expressway	Federal Highway	State Highways & Major Municipal Routes	Municipal and FELDA Routes	Municipal and FELDA Routes
Uncontrolled Crossing	C	B	B	B	B
School Children's Crossing	C	B	B	A	A
Pedestrian (Zebra) Crossing	C	B	A	A	A
Signalised Pedestrian Crossing*	C	A	B	B	C
Grade Separated Pedestrian Crossing	A	B	B	C	C

Notes: 'A' Indicates a treatment which is most likely to be the appropriate treatment

'B' Indicates a treatment which may be an appropriate treatment

'C' Indicates a treatment which is most likely not the appropriate treatment

Indicates facilities which may incorporate speed control humps.

* Not at an Intersection. Includes 'Pelican' and 'Puffin' type crossings.

FIGURE 1. GUIDE FOR SELECTING THE MOST APPROPRIATE TYPE OF PEDESTRIAN CROSSING FACILITY

Appendix 5.5:

Road Gradient

TABLE 4-6: MAXIMUM GRADES

Design Speed (km/hr)	Desirable Maximum Grade (%)	Maximum Grade (%)
120	2	5
100	3	6
80	4	7
60	5	8
50	6	9
40	7	10
30	8	12
20	9	15
Road Standard R1a	10	25

The desirable maximum should be aimed at in most cases. The maximum grades should be used infrequently. The total upgrade for any section of road should not exceed 3000m, unless the grade is less than 4%.

Appendix 5.6:

New Pedestrian Crossing Cost Estimation

New Pedestrian Crossing Type 1

Total Estimation of Cost for Type 1 Crossing

Item	Description	Amount (RM)
1	Pavement	82,586.00
2	Earthworks	65,033.00
3	Retaining Wall	456,647.00
4	Box culvert	105,600.00
5	Road facilities	128,898.00
	Total	838,764.00

ITEM	ITEM DESCRIPTION	UNIT	RATE (RM)	QTY	AMOUNT (RM)
1	**NEW PAVEMENT** Supply, lay, grade and compact as specified.				
1.1	100mm thick Lower Sub-base.	sq.m	2.00	1,190	2380
1.2	250mm thick Upper sub-base.	sq.m	5.00	1,190	5950
1.3	350mm thick crushed aggregate Roadbase.	sq.m	14.70	1,190	17493
1.4	Bituminous prime coat SS-1 or SS-1K.	sq.m	1.00	1,190	1190
1.5	100mm thick Dense Bituminous Macadam (DBM 40).	sq.m	19.00	1,190	22610
1.6	Bituminous Tack Coat	sq.m	0.80	1,190	952
1.7	60mm thick asphaltic concrete binder course ACB 28.	sq.m	12.90	1,190	15351
1.8	Bituminous Tack Coat	sq.m	0.80	1,190	952
1.9	60mm thick asphaltic concrete wearing course ACW 20.	sq.m	13.20	1,190	15708
				Total	82586

ITEM	ITEM DESCRIPTION	UNIT	RATE (RM)	QTY	AMOUNT (RM)
2.1	**General Site Clearance**				
2.1.1	Clearing and grubbing in the area shown on the Drawings and/or directed by the P.D. Clearing shall include all structures above and below ground in the way of construction limit, including fences, kerbs, drains, culverts, walls, signages poles, shrubs, trees, etc. but excluding buildings.	ha	1,800.00	0.3	540.00
2.2	**FILL, SPREAD, GRADE AND COMPACT**				
2.2.1	Imported suitable material as fill in embankments	cu.m	11.00	5,863	64,493.00

65,033.00

Nehamiah's Wall Cost Estimation

Used comparison method

* For 228 m2	=	178280
For 520 m2	=	456647

* Based on Nehamiah Wall cinstruct on Ipoh - Lumut Highwat Project

Box Culvert

ITEM	ITEM DESCRIPTION	UNIT	RATE (RM)	QTY	AMOUNT (RM)
3	Hume GSBC	lin.m	4800	22	105600

ITEM	ITEM DESCRIPTION	UNIT	RATE (RM)	QTY	AMOUNT (RM)
4.1	**GUARDRAILS**				
4.1.1	Supply, deliver and install single face guardrails inclusive of galvanise steel posts, washers, nuts, and accessories; all in accordance with specification and drawings.	lin.m	85.00	340.00	28900
4.1.2	Supply, deliver and install double face guardrails inclusive of galvanise steel posts 4.0m c/c, washers, nuts, delineators and accessories; all in accordance with specifications and drawings.	lin.m	156.00	170.00	26520
4.1.3	Ditto 2.0m c/c ditto	lin.m	203.00	300.00	60900
4.1.4	Single sided galvanised iron reflector strips on guardrails 4m c/c where necessary.	No.	12.00	245.00	2940
4.1.5	Road studs.	No.	20.00		0
4.2	**KERBS** Road kerbs type SM2; precast concrete L-shape profile; including insitu concrete beds and haunchings all as per drawing.				
4.2.1	Median Kerb	lin.m	35.00	340	
4.2.2	Edge Kerb	lin.m	35.00	244	8540
4.2.3	Two coats thermoplastic paints 300mm girth to concrete kerbs.	lin.m	4.50	244	1098
					128898

New Pedestrian Crossing Type 2

Total Estimation of Cost for Type 2 Crossing

Item	Description	Amount (RM)
1	Pavement	82,586.00
2	Earthworks	63,097.00
3	Retaining Wall	406,603.00
4	Box culvert	316,800.00
5	Road facilities	128,898.00
	Total	997,984.00

ITEM	ITEM DESCRIPTION	UNIT	RATE (RM)	QTY	AMOUNT (RM)
1	**NEW PAVEMENT** Supply, lay, grade and compact as specified.				
1.1	100mm thick Lower Sub-base.	sq.m	2.00	1,190	2380
1.2	250mm thick Upper sub-base.	sq.m	5.00	1,190	5950
1.3	350mm thick crushed aggregate Roadbase.	sq.m	14.70	1,190	17493
1.4	Bituminous prime coat SS-1 or SS-1K.	sq.m	1.00	1,190	1190
1.5	100mm thick Dense Bituminous Macadam (DBM 40).	sq.m	19.00	1,190	22610
1.6	Bituminous Tack Coat	sq.m	0.80	1,190	952
1.7	60mm thick asphaltic concrete binder course ACB 28.	sq.m	12.90	1,190	15351
1.8	Bituminous Tack Coat	sq.m	0.80	1,190	952
1.9	60mm thick asphaltic concrete wearing course ACW 20.	sq.m	13.20	1,190	15708
				Total	82586

ITEM	ITEM DESCRIPTION	UNIT	RATE (RM)	QTY	AMOUNT (RM)
2.1	**General Site Clearance**				
2.1.1	Clearing and grubbing in the area shown on the Drawings and/or directed by the P.D. Clearing shall include all structures above and below ground in the way of construction limit, including fences, kerbs, drains, culverts, walls, signages poles, shrubs, trees, etc. but excluding buildings.	ha	1,800.00	0.3	540.00
2.2	**FILL, SPREAD, GRADE AND COMPACT**				
2.2.1	Imported suitable material as fill in embankments	cu.m	11.00	5,687	62,557.00

63,097.00

Nehamiah's Wall Cost Estimation

Used comparison method

* For 228 m2	=	178280
For 520 m2	=	406603

* Based on Nehamiah Wall cinstruct on Ipoh - Lumut Highwat Project

Box Culvert

ITEM	ITEM DESCRIPTION	UNIT	RATE (RM)	QTY	AMOUNT (RM)
1	Hume GSBC	lin.m	4800	66	316800

ITEM	ITEM DESCRIPTION	UNIT	RATE (RM)	QTY	AMOUNT (RM)
5.1	GUARDRAILS				
5.1.1	Supply, deliver and install single face guardrails inclusive of galvanise steel posts, washers, nuts, and accessories; all in accordance with specification and drawings.	lin.m	85.00	340.00	28900
5.1.2	Supply, deliver and install double face guardrails inclusive of galvanise steel posts 4.0m c/c, washers, nuts, delineators and accessories; all in accordance with specifications and drawings.	lin.m	156.00	170.00	26520
5.1.3	Ditto 2.0m c/c ditto	lin.m	203.00	300.00	60900
5.1.4	Single sided galvanised iron reflector strips on guardrails 4m c/c where necessary.	No.	12.00	245.00	2940
5.1.5	Road studs.	No.	20.00		0
5.3	KERBS Road kerbs type SM2; precast concrete L-shape profile; including insitu concrete beds and haunchings all as per drawing.				
5.3.1	Median Kerb	lin.m	35.00	340	
5.3.2	Edge Kerb	lin.m	35.00	244	8540
5.3.3	Two coats thermoplastic paints 300mm girth to concrete kerbs.	lin.m	4.50	244	1098
					128898